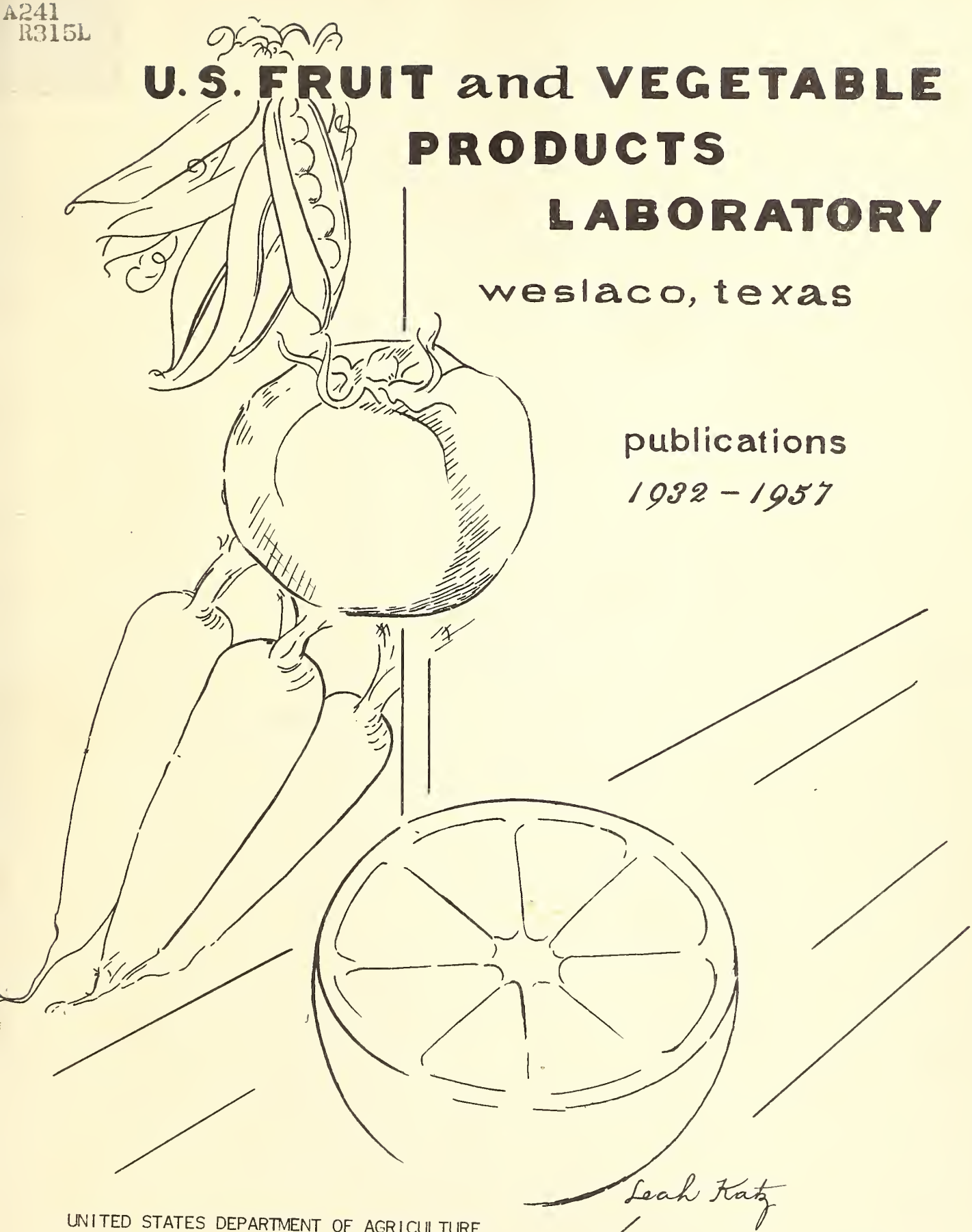
U.S. FRUIT and VEGETABLE PRODUCTS LABORATORY

weslaco, texas



publications

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UNITED STATES DEPARTMENT OF AGRICULTURE

AGRICULTURAL RESEARCH SERVICE

UNITED STATES DEPARTMENT OF AGRICULTURE
AGRICULTURAL RESEARCH SERVICE
SOUTHERN UTILIZATION RESEARCH AND
DEVELOPMENT DIVISION

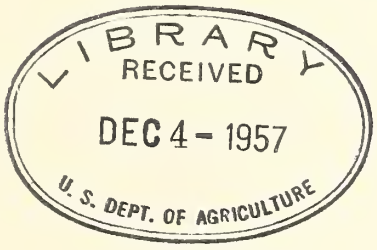
A LIST OF PUBLICATIONS, WITH ABSTRACTS,

REPORTING WORK

of the

U. S. FRUIT AND VEGETABLE PRODUCTS LABORATORY

WESLACO, TEXAS



Compiled and Edited

by

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SOUTHERN UTILIZATION RESEARCH AND DEVELOPMENT DIVISION

Made up of laboratories of the Agricultural Research Service of the U. S. Department of Agriculture, the Southern Utilization Research and Development Division is engaged in research on utilization of crops grown in the Southern Region, comprising Alabama, Arkansas, Florida, Georgia, Louisiana, Mississippi, North Carolina, Puerto Rico, Oklahoma, South Carolina, Tenneessee, and Texas. Headquarters for the Division are located at:

Southern Regional Research Laboratory
1100 Robert E. Lee Boulevard
New Orleans 19, Louisiana

This laboratory conducts research on utilization of cotton, cottonseed, rice, tung, peanuts and other oilseeds, sugarcane, and sweetpotatoes, and on fundamental chemistry and process engineering and development applicable to utilization of these products. Field stations are:

Sugarcane Products Laboratory, Houma, Louisiana
Tung Oil Laboratory, Bogalusa, Louisiana
Naval Stores Station, Olustee, Florida
Citrus Products Station, Winter Haven, Florida
Food Fermentation Laboratory, Raleigh, North Carolina
Fruit and Vegetable Products Laboratory, Weslaco, Texas

For information on any of the lines of research being conducted in the Southern Utilization Research and Development Division, you are invited to write or visit the Southern Regional Research Laboratory, or the field station immediately concerned with the product in which you are interested.

U. S. FRUIT AND VEGETABLE PRODUCTS LABORATORY
Weslaco, Texas

The U. S. Fruit and Vegetable Products Laboratory, at Weslaco, Texas, now a part of the Southern Utilization Research and Development Division of the Agricultural Research Service, USDA, is one of several such laboratories established in the early 1930's by the U. S. Department of Agriculture to conduct research on the processing and utilization of Southern farm crops.

A major problem in the grapefruit industry of Texas and Florida at the present time is the processing of pink and red grapefruit, and attention of research workers at the U. S. Fruit and Vegetable Products Laboratory is directed now toward finding a solution. When pink grapefruit was first introduced the attractive color made this fruit a luxury item which brought premium prices in the fresh market, and the same thing occurred when the still more distinctive red grapefruit appeared. As a result, these varieties are selected most frequently for new plantings in Texas. Although canning of grapefruit juice has been a well-established industry for a number of years, methods which resulted in a satisfactory canned juice from the original yellow or "white" varieties have not been equally successful when applied to the colored grapefruit.

Profitable outlets for fruit unsuitable to the fresh market are essential to a healthy citrus industry, and it was to meet this need for a satisfactory method of processing colored grapefruit that work on this project was undertaken at the Weslaco laboratory. A process now being developed there shows great promise for the production of a canned juice which would carry the natural color of the red and pink grapefruit. Limited studies already conducted indicate that a colored frozen concentrate may also be produced by similar methods. Other phases of the problem also under study at this time include seasonal development and fading of color.

Growing interest in avocados as a crop for the Southern United States has brought about a demand among prospective producers for processed products to utilize surplus or unsalable fruit, and some work is now being done on this problem at the Weslaco Laboratory. Work has been expanded also on the processing of vegetables grown in the South, including tomatoes, Southern peas (blackeye, purple hull, crowder, and cream), snap beans, and others.

This adaptability to the needs and requirements of the fruit and vegetable industry of the South has characterized the work of the Weslaco Laboratory from its beginning.

Utilization research on citrus was started by the USDA in California in 1911, and considerable knowledge had been accumulated by the time the laboratory was established in 1931. The newly-developed Texas citrus industry had reached important commercial proportions in the late twenties,

and growers found that instead of gaining additional returns from the sale of cull fruit for processing, cost of its disposal cut into profits from the marketable crop. In addition to expenses thus incurred, this condition led to the shipment of much fruit of undesirable size or appearance, thus bringing down the level of prices for all grapefruit, and reducing returns from the crop still further. To meet demands of the South Texas citrus area for help in this situation, Congress appropriated $10,000 in 1931 to finance equipment and operation of a laboratory, a site and building to be supplied by local interests. Sufficient money was raised to construct a small frame building on the grounds of the Texas Agricultural Experiment Station, Substation No. 15 at Weslaco, where the laboratory remained until the USDA constructed a tile building within the city of Weslaco. The building was dedicated in 1939. The first technical staff consisted of a single worker, but it was doubled in 1932 with the appointment of an assistant. For the next several years, the primary function of these two workers was to bring available technical information to the Texas citrus industry and to assist in its local application. Flash pasteurization, which is still the most satisfactory method for processing of citrus juice for canning, was new at that time. Technical men at the Weslaco Laboratory aided in introduction of the process in that area, advised on the design, installation, and operation of plant equipment, and supplied expert counsel on other processing problems.

The grapefruit canning industry was in a period of rapid development and change, bringing new problems. The switch from hand reaming to mechanical juice extraction caused difficulties from excessive peel oil in the juice. A precise method for the determination of oil, developed by the laboratory staff, made possible closer quality control in the plant during regular operations. It was also adopted by the USDA Agricultural Marketing Service as a standard grading method. To reduce the amount of oil getting into the juice, a heat pretreatment for grapefruit was developed and standardized; it was adopted generally throughout the grapefruit juice canning industry in both Texas and Florida, and was credited with saving millions of dollars which would have been lost through lowered quality.

During this period special efforts were made to disseminate information about citrus and vegetable processing in the South Texas area, and many of the papers abstracted in this list appeared in local publications where they would come to the attention of persons immediately interested.

In 1932, before canning of citrus products began in the Texas citrus-producing area, growers were paying $2.50 per ton to dispose of cull fruit; by 1937 growers were receiving more than a million dollars a year for their culls. During the four peak seasons, 1944-45 to 1947-48, an annual average of 9.4 million boxes of grapefruit, about 40% of the Texas crop, were processed to yield almost nine million cases of juice, basis 24/2's and about 270,000 cases of sections were processed. Returns from processed citrus during these years averaged about $16 million annually.

While the Fruit and Vegetable Products Laboratory at Weslaco was originally established to help the citrus industry, its work was almost immediately broadened to include research on canning and freezing of various kinds of vegetables as well as research on various other fruits. Such research has been continued up to the present time, and in recent years has been expanded.

42. PREPARATION OF A FROZEN AVOCADO MIXTURE FOR GUACAMOLE (Reprints)
Stephens, T. S.; Lime, B. J.; Griffiths, F. P.
J. Rio Grande Valley Hort. Soc. 11: 82-89. 1957

Exploratory experiments were initiated to study such variables as yield of edible flesh, and the method, kind of packaging, and variety, as they affect the quality of an avocado product such as guacamole "base". The first part of the experiment was conducted with a composite sample prepared from a blend of several varieties of avocados and packed in polyethylene bags and glass jars. The second part was intended to show the effects of variety or strain on the base. Samples from 12 varieties or strains of avocados were prepared and packed in 6-oz. plain tin cans. Samples packed in glass jars and tin cans were divided into thirds; from one third the air was withdrawn before containers were sealed; from another third air was replaced with nitrogen, and the final third was kept as a control. All samples were frozen and stored in still air at 0°F. At the end of three months' storage and again at the end of seven months, samples were evaluated. Guacamole base kept well for seven months at 0°F. storage when packed in glass jars or tin cans. Samples in polyethylene bags were discolored and rancid at the end of three months. Edible portions of the varieties and strains tested varied from 71% to 40.6%. The Topa variety rated high for making guacamole base, and the C-3 and 21-6 strains were the poorest. The Y-7 strain made the most flavorful and best colored base, but was lowest in yield and most difficult to prepare.

41. VEGETABLE PROCESSING PROBLEMS OF THE SOUTH TEXAS AREA: I. VALLEY'S TOMATO YIELDS TOO LOW. II. STAKING BEANS BEST
Griffiths, F. P.; and Stephens, T. S.
Texas Farming & Citriculture 33(3): 42; 33(4): 20-21. 1956

Problems of agronomy, disease, climate, water, and soil, in the Lower Rio Grande Valley of Texas are reviewed with consideration of their influence on quality and utilization of the crops. Principal canning crops are green beans, tomatoes, and beets. Lesser amounts of southern peas, carrots, okra, broccoli, cauliflower, and spinach are canned or frozen. Major needs are better color in tomatoes, firmer and higher yielding green beans, even-maturing and disease-resistant southern peas, carrots, okra, and spinach. Discoloration of canned beets is one of the processing problems.

40. VARIETY AND STRAIN EVALUATION OF SOUTHERN PEAS (Reprints)
*Correa, R. T.; and Stephens, T. S.
J. Rio Grande Valley Hort. Soc. 10: 90-95. 1956

Sixteen varieties and new strains of southern peas were grown and evaluated for yield and processing quality. Commercial Purple Hull was the highest producer of green pod peas for the blackeye-purple hull group, and Cream 52 Sp 16 strain for the cream group. Drained weight and tenderometer values were compared in an effort to establish an instrumental measure of maturity, but no relationship between tenderometer value, shellout percentage or drained weight was shown by this study. The canned peas were also evaluated for defects, splits, color, flavor, and appearance. Findings on all of these qualities are presented in tabular form.

39. PROCESSING CHARACTERISTICS OF COLORED TEXAS GRAPEFRUIT. II. CORRELATION OF COLOR MEASUREMENTS AND PIGMENT ANALYSES OF RUBY RED GRAPEFRUIT (Reprints)
Lime, B. J.; Stephens, T. S.; and Griffiths, F. P.
J. Rio Grande Valley Hort. Soc. 10: 53-63. 1956

Reflectance measurements of the blended puree of Ruby Red grapefruit provide an index of seasonal variations of fruit color. The pigmentation of the puree measured as the ratio of total lycopene to twice the carotene value agrees well with the Gardner Automatic Color Difference Meter reflectance ratio a/b. Seasonal reflectance measurements on fruit samples indicate slightly higher coloration in the fruit from the sandy soil. Color declined and Brix:acid ratio increased as the season progressed.

38. EFFECT OF BENZENE HEXACHLORIDE AND LINDANE ON THE FLAVOR OF PURPLE HULL PEAS (Reprints)
*Wene, G. P.; **Otey, G. W.; and Griffiths, F. P.
Proc. Am. Soc. Hort. Sci. 64: 390-92. 1954

Experimental plots of purple hull peas were variously treated with one dusting and three dustings 3% benzene hexachloride; one and three dustings 3% lindane, and three dustings 1% lindane. Peas were then canned, and flavor evaluated against an untreated control. Results indicated that use of lindane as an insecticidal dust on fields of purple hull peas did not result in an objectionable flavor carryover into processed peas. Processed peas from plots having either single or triple applications of commercial benzene hexachloride had a detectable off-flavor.

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* Texas Agr. Expt. Sta. Substation No. 15, Weslaco, Texas
** Rio Farms, Inc., Edcouch, Texas

37. FROZEN GRAPEFRUIT, TANGERINE, AND LIMEADE CONCENTRATES (Reprints)
Veldhuis, M. K.; Scott, W. C.; and Griffiths, F. P.
Food Technol. 9(4): 198-201. 1955

The principal properties and problems of frozen grapefruit, tangerine, and limeade concentrates are discussed. Grapefruit concentrates are somewhat lacking in stability, therefore heat treatment is used to improve cloud stability. Tangerines are fragile, irregular in shape, and present problems in juice extraction and finishing. Lime juice may be merely sweetened in the preparation of concentrate for limeade or more concentrated products may be prepared by evaporation under low pressure and reinforcement of flavor with puree. Satisfactory frozen concentrates have been commercially prepared from all three types of fruit. Results of laboratory analyses are given for nine samples of grapefruit, three of tangerine, and eight of limeade concentrates.

36. RESEARCH INDICATES NEW TRENDS IN CITRUS PROCESSING
Griffiths, F. P.; and Jones, M. A.
In "Building the Citrus Industry of the Lower Rio Grande Valley". Published by United Citrus Growers, Pharr, Texas, 1954, pp. 21, 23.

A satisfactory method of processing pink and red grapefruit unsalable in the fresh state is the most pressing problem of the citrus canning industry in the Lower Rio Grande Valley of Texas. Two methods are being explored. Two other grapefruit products have been studied -- a frozen concentrate, and a concentrate to keep at temperatures of 40°F. or higher. Frozen limeade base also appears to have possibilities.

35. PROCESSING CHARACTERISTICS OF COLORED TEXAS GRAPEFRUIT. I. COLOR AND MATURITY STUDIES OF RUBY RED GRAPEFRUIT (Reprints)
Lime, B. J.; Stephens, T. S.; and Griffiths, F. P.
Food Technol. 8(12): 566-69. 1954

To process juice from colored grapefruit successfully, more information was necessary about the development of color, and its relation to maturity. For opening studies on this problem the Ruby Red was selected because it is probably the most widely planted of the colored varieties in Texas. Measurements of color and of some chemical and physical characteristics were made at intervals of 2 weeks for about 8½ months. These measurements included visual and reflected color; average weight; Brix, acid, naringin, lycopene, and carotene content. Color was strongest early in the season, before fruit reached its peak of processing quality, and had begun to fade when this peak had been reached. These studies indicate that the combination of good color with high flavor characteristics is limited to a relatively short period.

34. NOTES ON THE PROCESSING CHARACTERISTICS OF LIMES (Reprints)
Griffiths, F. P.; Lime, B. J.; and Stephens, T. S.
Proc. Rio Grande Valley Hort. Inst. 8: 110-113. 1954

Mexican limes of the same type as those grown heretofore in the Lower Rio Grande Valley, known as West Indian, Key, or Mexican limes, were processed. These experiments have shown that a satisfactory limeade base for freezing can be made from Mexican limes if careful extraction procedures are used. Addition of sugar to bring the Brix up to 60° - 65° gives a base which upon dilution with 5 volumes of water yields a limeade containing approximately 0.75 gram acid per 100 ml. and 12-14% sugar.

33. PAPAYAS IN THE RIO GRANDE VALLEY
Griffiths, F. P.
Texas Farming & Citriculture 30(6): 4,24. 1953

Trees bear fruit 12 to 18 months after planting. Papain may be obtained from the green fruit, but labor costs appear too high for profitable production in this area. Use of the green fruit as a vegetable and preparation of the ripe fruit for table use, or as frozen or canned puree or cubes, is described. A dried meal prepared from the leaves is used to some extent in animal feeds.

32. STABILIZATION OF GRAPEFRUIT CONCENTRATES -- A PROGRESS REPORT
Huffman, W. A. H.; Lime, B. J.; and Scott, W. C.
Proc. Rio Grande Valley Hort. Inst. 7:106. 1953
Also published in Proc. Assoc. Southern Agr. Workers 50:142. 1953

A report on studies in progress on methods of preparing a concentrate from Texas-grown grapefruit which will remain stable for 6 to 12 months when stored at 40° F. (4.4° C.) or higher. Possible stabilizing methods investigated to date, singly and in combination include: Pasteurization, filling and sealing concentrates under superheated steam; addition of terpeneless oil to enhance flavor and aroma of heat-treated concentrates, varying the degree of concentration; addition of chemical preservatives and anti-oxidants; and adjusting the Brix-acid ratio by the addition of citric acid and sugars.

31. PROCESSED JUICES FROM TEXAS RED AND PINK GRAPEFRUIT - A PROGRESS REPORT (Reprints)
Huffman, W. A. H.; Lime, B. J.; and Scott, W. C.
Proc. Rio Grande Valley Hort. Inst. 7: 102-105. 1953

Preliminary results are encouraging for the preparation of canned single-strength pink grapefruit juice and pink frozen concentrates using the naturally occurring ingredients of the fresh fruit. It is practical to blend juice from white grapefruit with centrifuged juice from red or pink varieties, but this method does not capitalize on the natural pigmentation of colored citrus.

30. CHANGES IN PROCESSING METHODS TO AVOID DARKENING IN CANNED TEXAS VALLEY BEETS (Reprints)
Huffman, W. A. H; Lime, B. J.; and Scott, W. C.
Proc. Rio Grande Valley Hort. Inst. 7: 143-47. 1953

Laboratory studies, together with observations of the general processing conditions found in several canning plants, indicate the need for changes in processing procedures and equipment to avoid darkening in canned beets. It appears that darkening can be reduced and probably held within acceptable limits by use of adequate steam exhaust. Quality of canned beets could also be improved by replacing iron equipment with stainless steel or other suitable material, and by more expeditious handling during processing.

29. IDENTIFICATION OF SUGARS IN "RIO SWEET" CANTALOUPES (Reprints)
Huffman, W. A. H.; Scott, W. C.; and Lime, B. J.
Proc. Rio Grande Valley Hort. Inst. 6: 83-86. 1952

In work at the U. S. Fruit and Vegetable Products Laboratory, D-sucrose, D-glucose, and D-fructose were detected, by means of paper chromatography, as constituent sugars in "Rio Sweet" cantaloupe, a new, disease-resistant variety developed at Substation No. 15 of the Texas Experiment Station. Acid hydrolysis revealed no additional sugars. Aqueous extracts gave the same qualitative results as 80% alcoholic extracts.

28. INDUSTRIAL UTILIZATION OF CITRUS CANNERY WASTE
Scott, W. C.
Citrus Leaves 28(7): 30, 32, 34. 1948

For the United States as a whole, approximately half of the citrus crop is marketed as fresh fruit. Processing of the other half of the crop results in about 20% of the total tonnage being distributed as processed food products, such as canned juice and sections. The remaining 30% goes into by-products, chiefly stock feed. In 1947 approximately 93% of

all citrus cannery waste in Texas was converted to feed. Other citrus byproducts include molasses, essential oils, pectin, alcohol, and feed yeast, but their production is so small as to have little effect on the economy of the industry.

27. PROCESSING AS AN ADDITIONAL OUTLET FOR CITRUS FRUIT
Scott, W. C.
Proc. Rio Grande Valley Hort. Inst. 1: 73-76. 1946
Republished as OUTLINES OF CITRUS PROCESSING
Texas Farming & Citriculture 24(5): 4-5. 1947

Growth of the citrus processing industry in South Texas is outlined, from 1930, when it was non-existent, and growers were forced to bury cull fruit at a cost of $2.50 per ton, to 1945-46, when canners paid more than $9 million for culls. Canned grapefruit juice accounted for most of this output in the area, with blended orange and grapefruit juice the second in popular favor. Canned sections are a popular item with the consumer, but are packed in small quantities because of higher labor costs. Vacuum-concentrated frozen orange juice is said to be the best of the orange products so far developed. Grapefruit juice has not lent itself well to vacuum concentration, but the Weslaco laboratory is working on the problem. Stock feed, prepared by dehydration of solid waste from canning operations, is first among the byproducts in volume and dollar value. Essential oils and pectin are mentioned as other byproducts of some value.

26. DEHYDRATION OF TEXAS-GROWN SNAP BEANS (Reprints)
Pentzer, D. J.
Fruit Products J. 24(5): 136-37, 157. 1945

This study was undertaken to determine the adaptability to dehydration of different varieties of snap beans as grown in the Rio Grande Valley of Texas. It was found that a blanch of 10 minutes in flowing steam was required to produce a product that was tender after subsequent dehydration. This blanch was longer than that required to inactivate the enzymes. Dipping the blanched beans in a solution of sodium bicarbonate before dehydration did not improve the color of the reconsitituted dehydrated beans, but it did have a tenderizing effect. In testing 15 commercially and experimentally grown varieties, it was found that the Refugee variety gave the lowest quality rating of all varieties tested, while the Decatur and Blue Lake Stringless varieties gave the highest and second highest quality ratings, respectively. Beta-carotene content of these varieties followed the color and quality ratings in a general way, the deepest-green variety having the most carotene (53.7 ppm dry basis) and the lightest-green variety, the least carotene (20.1 ppm dry basis).

25. PRESERVATION OF PINEAPPLE WITH SULFUR DIOXIDE (Reprints)
Scott, W. C.; and Pentzer, D. J.
Fruit Products J. 23(7): 206, 213, 217. 1944

Pineapple was found to be well preserved with sulfur dioxide, but not with sodium benzoate. When preserved with sulfurous acid the color and flavor were adequately maintained for test periods of eight weeks at 110° F. and for three months at room temperature. Addition of sugar at the time of crushing had no effect on the quality of the preserved product. Sulfur dioxide was readily removed from the crushed fruit. Twenty minutes of vigorous boiling was sufficient to reduce the sulfur dioxide content well below the point where it is readily detected by taste. Preservation of the fruit in large pieces is effective, but crushing is recommended for the conservation of shipping weight and space, and to allow ready removal of sulfur dioxide. Blanching pineapple to destroy enzymes is not recommended. Bromelin is slowly but steadily inactivated during storage.

24. SIGNAL PROGRESS WITH FRUIT AND VEGETABLE BY-PRODUCTS
Anon.
Texas Farming & Citriculture 21(4): 24. 1944

History of the laboratory from its establishment in 1931 to the present is recounted. J. L. Heid was the first chemist in charge, and was assisted by W. C. Scott. Upon Heid's resignation in 1941 Scott became chemist in charge and D. J. Pentzer came from the Pacific Northwest as assistant chemist. Among accomplishments cited for the early years was the installation in 1934, largely through efforts of the Laboratory staff, of the first grapefruit juice canning plant using flash pasteurization; development of a method for quick determination of oil in citrus juices, adopted as the official method for use in all citrus-producing areas; and pretreatment for control of peel oil in grapefruit juice used in both Texas and Florida; and contribution to establishment of a feed industry utilizing citrus peel and pomace. During the war years work of the laboratory was concentrated on vegetable dehydration, and on development of formulas for sulfur dioxide preservation of fruit pulps for Lend-Lease. Several lines of research needing attention for the future are suggested.

23. DEHYDRATION RESEARCH AT THE FRUIT AND VEGETABLE PRODUCTS LABORATORY, WESLACO, TEXAS
Scott, W. C.
Southern Canner and Packer 4(12): 9. 1943

This is a report of a talk made before the Southern Dehydration Conference in Longview, Texas, Oct. 20, 1943, and summarizes the information contained in "Quality and Vitamin Content of Dehydrated Vegetables", No. 24 abstracted herein.

22. QUALITY AND VITAMIN CONTENT OF DEHYDRATED VEGETABLES
Scott, W. C.
Quick Frozen Foods 6(4): 42, 44. 1943

One or more season's work has been done on carrots, green beans, sweetpotatoes, beets, and onions. Imperator carrots, the variety most widely grown in South Texas, is second only to Nantes in quality of the dehydrated product. Dehydrated and reconstituted Stringless Green Pod and Tendergreen varieties of green beans compared favorably with the canned product, and the quality of dehydrated sweet Bermuda onions was high. Contrary to ideas widely accepted, thorough tenderization of the vegetables is recommended by Laboratory workers to insured products which reconstitute properly, and are completely tender. Blanching times recommended are 20 minutes for carrots and sweetpotatoes, 12 minutes for Irish potato strips and green beans of No. 4 sieve size. They also recommend high initial temperatures at the lowest possible humidity for dehydration.

21. DEHYDRATION TESTS ON RIO GRANDE VALLEY CARROTS - 1942-43 (Reprints)
Pentzer, D. J.; and *Wood, J. F.
U. S. Dept. Agr., Bur. Agr. and Ind. Chem., Mimeo. Circ. Ser. AIC-30, 5 pp., processed. 1943
(Also issued as Texas Agr. Expt. Sta. Progr. Rept. 842, 1 p., processed. 1943)

Wartime demands turned attention of the Weslaco Laboratory to studies on dehydration of vegetables grown in South Texas, such as carrots. Eight varieties of carrots were used in the tests. Washed, topped carrots were lye-peeled, rinsed, and blanched for 20 minutes in flowing steam. Shorter blanches, while inactivating enzymes, were found to be insufficient to insure tenderness of the reconstituted product. The samples were then dehydrated to 8 to 10% final moisture content. The Nantes and Red Core Chantenay gave the best product, but the yield from the Nantes was comparatively low. Carrots harvested between 120 to 150 days after planting gave the best quality in the dehydrated product. Ascorbic acid assays showed retention best in the younger carrots.

20. PRETREATMENT OF GRAPEFRUIT FOR JUICE CANNING (Reprints)
Scott, W. C.
Canner 93(18): 11. 1941

Introduction of mechanical extraction into the grapefruit juice canning industry resulted in a problem of peel oil contamination. Such contamination might cause the quality of juice to vary from

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* Texas Agricultural Experiment Station, Substation No. 15, Weslaco, Texas

Grade A to Off-Grade in a single day's run. A method was developed for treating the whole fruit with steam or hot water prior to extraction; such treatments proved quite effective in reducing the recoverable oil in mechanically extracted juices. In a single test using boiling water for 60 seconds, the recoverable oil in juice extracted from Duncan fruit was reduced from 0.100% to 0.006%. Times and temperatures of treatment for different varieties of citrus are recommended.

19. THE FREEZING PRESERVATION OF CITRUS FRUITS AND JUICES
Heid, J. L.
U. S. Dept. Agr., Bur. Agr. Chem. and Eng., Mimeo. Circ. Ser. ACE-81, 6 pp., processed. 1941

Frozen storage is reported to be an efficient means of preserving untreated citrus fruits and juices with minimum deterioration of flavor and quality. The author outlines preparation methods which have been found satisfactory. Great care in the harvesting and preparation of the fruit is recommended. Only sound, mature fruit should be used, and rigid plant sanitation maintained. Juice should be extracted in such a manner as to minimize oil and other substances from the peel and rag. Detailed instructions are given for screening, sweetening and blending, filling, selection of containers, as well as storage, transportation, and preparation for use. Preparation of frozen orange and grapefruit sections is also described. Marsh and Duncan grapefruit varieties are said to be suitable for frozen juice; these varieties and pink or red variants for frozen sections. Valencia is said to be the best variety of orange for frozen juice, followed in order of preference by Temple, Hamlin, Parson Brown, and Navel.

18. DETERMINATION OF PEEL OIL IN GRAPEFRUIT JUICE (Reprints)
Scott, W. C.
J. Assoc. Offic. Agr. Chemists 24(1): 165-70. 1941

The adoption by the grapefruit juice canning industry of mechanical juice extractors has brought about the need for a method to measure the quantity of peel oil incorporated in the juice during extraction. Excessive quantities of peel oil in the juice impairs flavor and keeping qualities. A method for measuring the oil in the juice is described and illustrated. In principle, the method is steam distillation and recovery of the volatile oil in a receiver suitable for measuring a small quantity of oil lighter than water.

17. BY-PRODUCTS LABORATORY AIDING VALLEY. UTILIZATION OF CROPS BY CANNING, FREEZING, DRYING INVESTIGATED
Heid, J. L.
Mission Times (Seventh Ann. Texas Citrus Fiesta Edition) 31(15): 1, 5 (Sect. 6). Jan. 12, 1940

The situation in regard to the processing of Texas-grown fruits and vegetables is discussed generally, with specific reference to developments on production of feed from citrus cannery residues;

cannery waste disposal; and specialty products from citrus, vegetables, and subtropical fruits, such as the papaya. A large section of the paper is devoted to reports of investigations at the Laboratory into the freezing of vegetables grown in the area. Processing methods, suitable varieties, packaging, and other information of interest to commercial packers or freezers is presented in some detail, calling attention to information available at the Laboratory on this subject.

16. THE UTILIZATION OF FRUITS AND VEGETABLES IN THE RIO GRANDE VALLEY
Heid, J. L.
Fruit Products J. 20(1): 17-19, 25; 20(2): 44-46, 54. 1940
U. S. Dept. Agr., Bur. Agr. Chem. and Eng., Mimeo. Circ. Ser. ACE-30, 9 pp., processed. 1940

At the Fruit and Vegetable Products Laboratory at Weslaco, Texas, investigations are conducted on the utilization of Texas fruits and vegetables by canning, freezing, drying, fermenting, and recovery of byproducts; also upon the disposal of wastes and residues. In developing and demonstrating advantageous methods for using perishable crops the object is to provide growers with facilities for disposing of grades unsuitable for the fresh market, and for stabilizing markets by diversion of surpluses. About 200,000 tons go through processing plants annually, largely as a result of the development of methods which produce a juice of desirable quality. A steam-jacketed, coiled and flattened tubular pasteurizer designed at the Weslaco Laboratory is pictured and described. Other developments for the improvement of juice quality and advantageous disposal of cannery waste are presented. Work on papaya products, grapes, strawberries, and vegetables, including corn, peas, tomatoes and carrots is reviewed. The second installment is devoted to freezing of fruits and vegetables. Necessity of careful selection and preparation of the raw material for freezing is stressed, and specific recommendations as to varieties and methods of processing for citrus juices, lima beans, snap beans, broccoli, and sweet corn are given.

15. THE PRESERVATION OF TEXAS FRUITS AND VEGETABLES IN FROZEN LOCKER STORAGE
Heid, J. L.
U. S. Dept. Agr., Bur. Agr. Chem. and Eng., Mimeo. Circ. Ser. ACE-60, processed. 1940
Also published as FROZEN LOCKER STORAGE DEVELOPED HERE, Mission Times 32(16): 6-7 (Sect. 4). Jan. 17, 1941

Suitable varieties of fruits and vegetables, whole, sliced, pulped, or in the form of juice, may be advantageously preserved, efficiently utilizing frozen locker storage. For best results, however, varieties must be selected for color, flavor, texture and adaptability for production and freezing under local conditions. General instructions

about preparation, utensils, blanching, containers, use of sugar syrups or brine, conditions of storage and thawing, are given in detail. Specific instructions applicable to different vegetables and fruits, and recommendations as to varieties, are given.

14. FRUITS AND VEGETABLES IN THE RIO GRANDE VALLEY
Heid, J. L.
Canner 90(18): 13-14. 1940

Scope of the fruit and vegetable processing industry in the area is indicated by statistics. About 600,000 tons of grapefruit are produced annually, of which one-third is processed, producing the equivalent of five million cases of 24 No. 2 cans of juice and sections are packed. Solid residue is converted into stock feed. Papayas are said to be a promising crop for the section, and processed products are suggested. Approximately 35 varieties of vegetables are grown, and 20,000 carloads shipped annually. Possibilities of frozen packs are explored, and packaging and varieties discussed.

13. CITRUS FRUIT PRODUCTS
Chace, E. M.; von Loesecke, H. W.; and Heid, J. L.
U. S. Dept. Agr. Circ. No. 577, 46 pp. 1940

A brief review of the status of the citrus-products industry, together with a statment of the composition of the common citrus fruits, is given, also a description in some detail of the commercial methods of preparation of citrus products. It may seem that in some cases, for example, the production of the essential oils, the text is adequate. This is because most of the devices now in use are the result of long study and experimentation on the part of the owners, and it would be manifestly improper to divulge their trade secrets. Methods for canning juice and segments, for producing beverage material, wines and brandies, vinegar, pectin, marmalades and marmalade stock, jellies, candied peel, and essential oils are given. There is also a brief statement on the disposal of waste. This circular has recently been revised and reissued as Agriculture Handbook No. 98, "Chemistry and Technology of Citrus, Citrus Products, and Byproducts".

12. FREEZING FRUITS AND VEGETABLES IN THE SOUTHWEST
Heid, J. L.
Refrig. Eng. 38(5): 286-88. 1939

Advantages of frozen over fresh or canned fruits and vegetables are discussed. Maintenance of quality requires close attention to every stage of manufacture, storage, and distribution. Methods of preparation, freezing, desirable freezing temperatures, and various types

of packaging are also described. Results of tests on the freezing of different varieties of citrus and vegetables grown in the Southwest are discussed in detail.

11. PROCESSING SOUTH TEXAS FRUITS AND VEGETABLES
Heid, J. L.
Texas Farming & Citriculture 15(6): 12-13. 1938

Growth of the grapefruit juice canning industry from $10,000 in 1934-35 to $1,200,000 in 1937-38 is reported with a review of the part played by the Laboratory in this growth. Investigations on vegetable processing have been authorized, and freezing tests on English peas, lima beans, green beans, broccoli and corn are reported. The paper includes a recipe for grapefruit butter.

10. NOTES ON SOME FACTORS AFFECTING THE QUALITY OF CANNED GRAPEFRUIT JUICE
Heid, J. L.; and Scott, W. C.
U. S. Dept. Agr., Bur. Chem. and Soils-52, processed. 1939

Forms of deterioration which may cause losses to commercial canners of grapefruit juice include: separation and clotting; darkening and staling; and development of rank, bitter, or terpeny flavors. Small quantities of peel oil in the juice contribute to the characteristic grapefruit flavor, but excessive quantities tend to develop a rank, terpeny flavor during prolonged or unfavorable storage. Heavy pressing or grinding during extraction or screening may result in the incorporation of excessive sediment, naringin, pectin, and pectic enzymes, with deleterious effect. Excessive pectin and pectic enzymes may cause clarification, clotting, curdling, or jellying. Pectic enzymes may be inactivated by heating, but when present in excessive quantities the time and temperature necessary to entirely inactivate them will impair the flavor of the juice. High storage temperatures and excessive headspace in the cans are also injurious to quality.

9. TEXAS FRUIT AND VEGETABLE JUICE PRODUCTS
Heid, J. L.
Canner 88(25): 16-17; (26): 16-17, 28. 1939

Early work of the Weslaco Laboratory in the development of the citrus canning industry is reviewed. Production of juice and other products from vegetables is surveyed; recent work of the Laboratory on the production of juices from Texas-grown carrots, tomatoes, and other vegetables is reported. Preparation of feed from dehydrated cannery residues, such as from citrus, tomatoes, and other vegetables is discussed. Yeast fermentation for disposal of liquid cannery waste has been introduced and is being practiced.

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8. THE USE OF CITRUS POMACE IN MAKING IMITATION JAMS
Heid, J. L.
Canner 87(6): 26. 1938

Formulas are given for the preparation of four specialty products from the citrus pulp remaining after extraction of the juice for canning. The formulas are for commercial-scale operations, and include a plain jam, spiced jam, spiced butter, and blended jam.

7. THE WORK AT THE CITRUS PRODUCTS STATION
Heid, J. L.
Texas Farming & Citriculture 13(11): 4, 22. 1937

At the time the U. S. Citrus Products Station in Weslaco began its work no citrus products plants were operating. Three plants began operation in 1933-34, paying approximately $10,000 for cull fruit; during the 1935-36 season 17 plants paid $70,000 for 25,000 tons of grapefruit. The laboratory investigated and recommended methods of reaming, screening, deaeration and flash pasteurization, and assisted in the designing and installation of plant equipment. Other work included developments on marmalade and marmalade base, grapefruit juice and pulp preserved with sulfur dioxide, grapefruit vinegar, alcoholic beverages, concentrates, frozen juices, and other products. Vegetable processing investigations, particularly on freezing, are mentioned.

6. THE PROCESSING OF CITRUS JUICES - OBSERVATIONS ON HEATING AND COOLING OPERATIONS
Heid, J. L.; and Scott, W. C.
Fruit Products J. 17(4): 100-04, 121. 1937

Heating and cooling operations on citrus juices in seven commercial canning plants were observed and data are given. These data bear out conclusions previously reported by the authors that the velocity of juice flow in tubular heaters is an important factor in determining the rate of heat transfer. Other factors in the operation of various types of equipment are also reported in detail. Formation of juice deposits capable of interfering with heat transfer through tube walls was not observed when juice velocities were maintained in excess of eight feet per second, provided the flow of juice was directed upward through tubes to avoid air pockets, and juice was flushed from the heater with water when operations were suspended.

5. THE CAPACITY OF FLATTENED TUBE JUICE PASTEURIZERS (Reprints)
Heid, J. L.; and Scott, W. C.
Fruit Products J. 16(5): 136-39. 1937

Steam-jacketed tubular beaters offer a rapid, inexpensive method for heating liquid foods; flattening of the tube reduces cross sectional area, increases velocity, and minimizes dependence upon

conduction of heat through layers of juice. Rapid, uniform heating and cooling is necessary to prepare citrus juice of good flavor and keeping quality. Factors affecting the heat transfer rate in tubular juice pasteurizers include: velocity and agitation of the juice; material and thickness of the tube; circulation of steam and removal of condensate; specific heats of juice and steam; temperature differences: initial, final, and average. Performance data on straight and coiled tubular juice pasteurizers are cited, and calculations made for pertinent data.

4. CITRUS PRODUCTS, 1934
Heid, J. L.
Proc. Texas Citrus Inst. 3: 27-30. 1934

The importance of citrus products in the development of a healthy citrus industry is described, and the need for research to develop such products is outlined.

3. MARMALADE STOCK AND MARMALADE (Mimeo. Sheet)
Scott, W. C.; and Heid, J. L.
Texas Citriculture 10(9): 18. 1934

Instructions are given for the preparation of marmalade stock from whole grapefruit, or from grapefruit with shredded peel. This stock may be canned in sealed containers and kept indefinitely. Instructions are given also for making the stock into marmalade. A recipe for calamondin marmalade is included. A machine for shredding the peel on the grapefruit is described.

2. OUTLOOK FOR CITRUS PRODUCT MANUFACTURE IN TEXAS
Heid, J. L.
Texas Citriculture 9(9): 8. 1933

Work of the newly established citrus research laboratory is outlined. It has been found that if juice from thoroughly mature fruit is properly extracted, deaerated, processed, and packed under scrupulous control, the product is highly palatable, and keeps well. Staff scientists are also cooperating with the Texas Department of Agriculture on a study of citrus maturity; they are investigating the preparation of grapefruit marmalade, and the use of waste from canning plants as a source of humus for farm lands.

1. CITRUS PRODUCTS INVESTIGATION IN TEXAS
Heid, J. L.
Texas Citriculture 8(8): 12-13. 1932

Need of the newly-established citrus industry of South Texas for a byproducts industry is outlined. Such an industry would bring additional income to growers, and provide an outlet for surplus or cull fruit. Growth of the canning industry is cited, and other avenues of exploration are suggested, such as quick freezing of juice and sections, marmalade, candied peel, peel and seed oil; pectin; bioflavonoids; and stock feed from the residual peel and pulp.

A U T H O R S
(By Item Numbers)

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